

Underground Storage Tank Installation Exhibit Book

API PUBLICATION 1663C
JANUARY 1995



American Petroleum Institute
1220 L Street, Northwest
Washington, D.C. 20005



STEP

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- To recognize and to respond to community concerns about our raw materials, products and operations.
- To operate our plants and facilities, and to handle our raw materials and products in a manner that protects the environment, and the safety and health of our employees and the public.
- To make safety, health and environmental considerations a priority in our planning, and our development of new products and processes.
- To advise promptly appropriate officials, employees, customers and the public of information on significant industry-related safety, health and environmental hazards, and to recommend protective measures.
- To counsel customers, transporters and others in the safe use, transportation and disposal of our raw materials, products and waste materials.
- To economically develop and produce natural resources and to conserve those resources by using energy efficiently.
- To extend knowledge by conducting or supporting research on the safety, health and environmental effects of our raw materials, products, processes and waste materials.
- To commit to reduce overall emissions and waste generation.
- To work with others to resolve problems created by handling and disposal of hazardous substances from our operations.
- To participate with government and others in creating responsible laws, regulations and standards to safeguard the community, workplace and environment.
- To promote these principles and practices by sharing experiences and offering assistance to others who produce, handle, use, transport or dispose of similar raw materials, petroleum products and wastes.

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SPECIAL NOTES

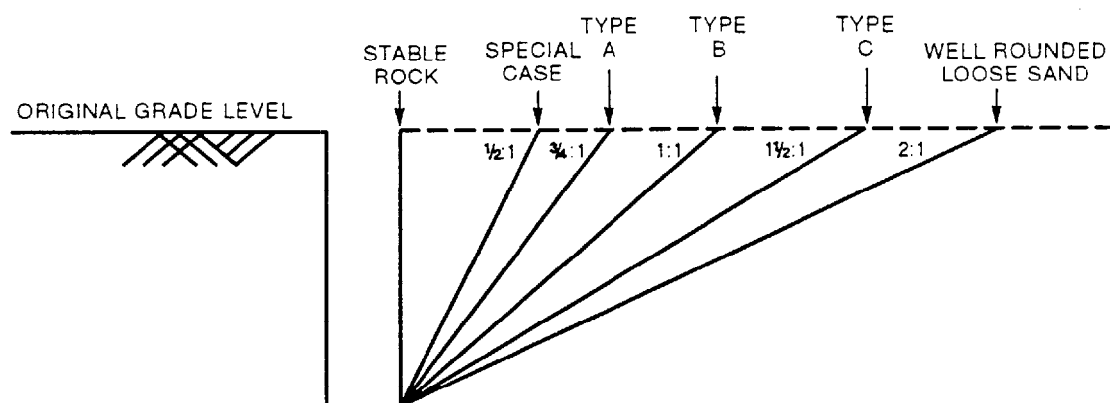
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Suggested revisions are invited and should be submitted to the director of the Manufacturing, Distribution and Marketing Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

EXHIBIT 1



For protective systems, there are four options permissible by law: (If different options result in different slope angles, you may use the steepest slope.)

1. Slope excavation at an angle not steeper than 1 1/2 feet horizontal to 1 foot vertical and in accordance with Type C soil described in 29 CFR 1926.650-652, Subpart P, Appendix B;
2. Slope excavation in accordance with the OSHA simplified soil classification system and 29 CFR 1926.650-652, Subpart P, Appendices A and B;
3. Use tabulated data sealed by a registered professional engineer in the state of the excavation for the protective system design;
4. Use a site specific protective system design sealed by a registered professional engineer in the state of the excavation.

Although Option Number 4 is probably the most commonly used, the information provided below is based on Option Number 2.

Maximum Allowable Slope (H:V) for Excavations Less Than 20 Feet Depth		
Soil or Rock Type		
Stable Rock	Vertical	90 degrees
Type A Soil	3/4 : 1*	53 degrees
Type B Soil	1:1	45 degrees
Type C Soil	1 1/2 : 1	34 degrees

Type A: Cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) or greater. Examples of cohesive soils are clay, silty clay, sandy clay, clay loam, and, in some cases, silty clay loam and sandy clay loam.

Type B: Cohesive soils with an unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf, or granular cohesionless soils including angular gravel (similar to crushed rock), silt, silt loam, sandy loam, and, in some cases, silty clay loam and sandy clay loam.

Type C: Cohesive soils with an unconfirmed compressive strength of 0.5 tsf or less, or granular soils including gravel, sand, and loamy sand.

Unstable soils are soils which have an unconfined compressive strength of less than 750 psf.

*OSHA regulations allow a maximum slope of 1/2:1 under the following conditions:

1. The excavation is in Type A soil.
2. The excavation is not open for more than 24 hours.
3. The depth of the excavation is 12 feet or less.

EXHIBIT 2

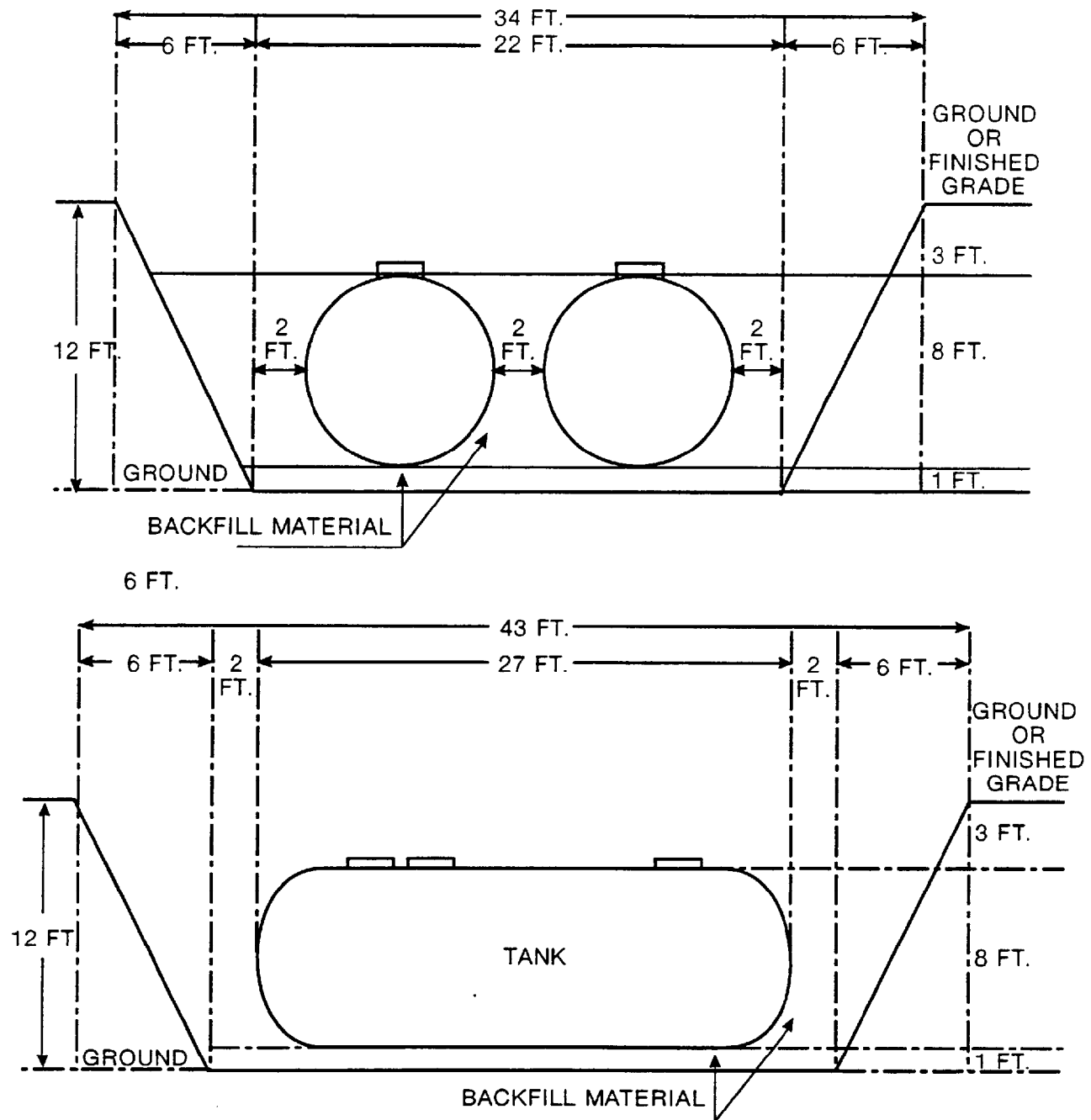


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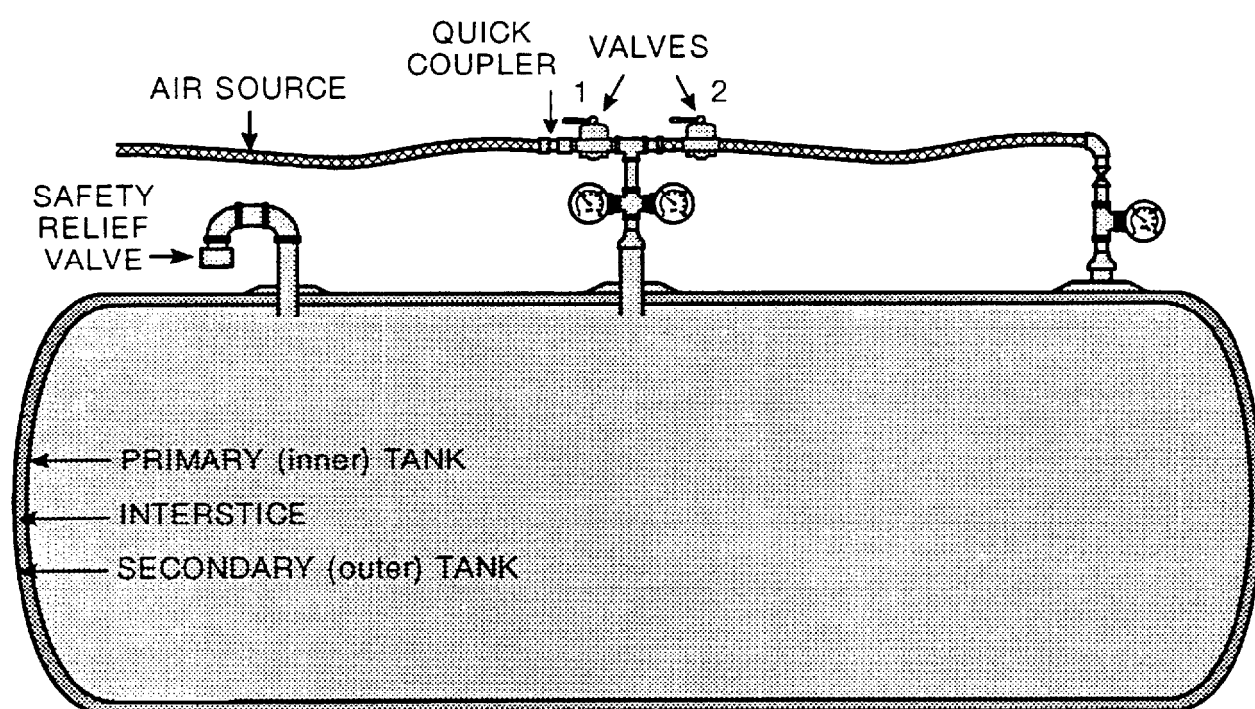


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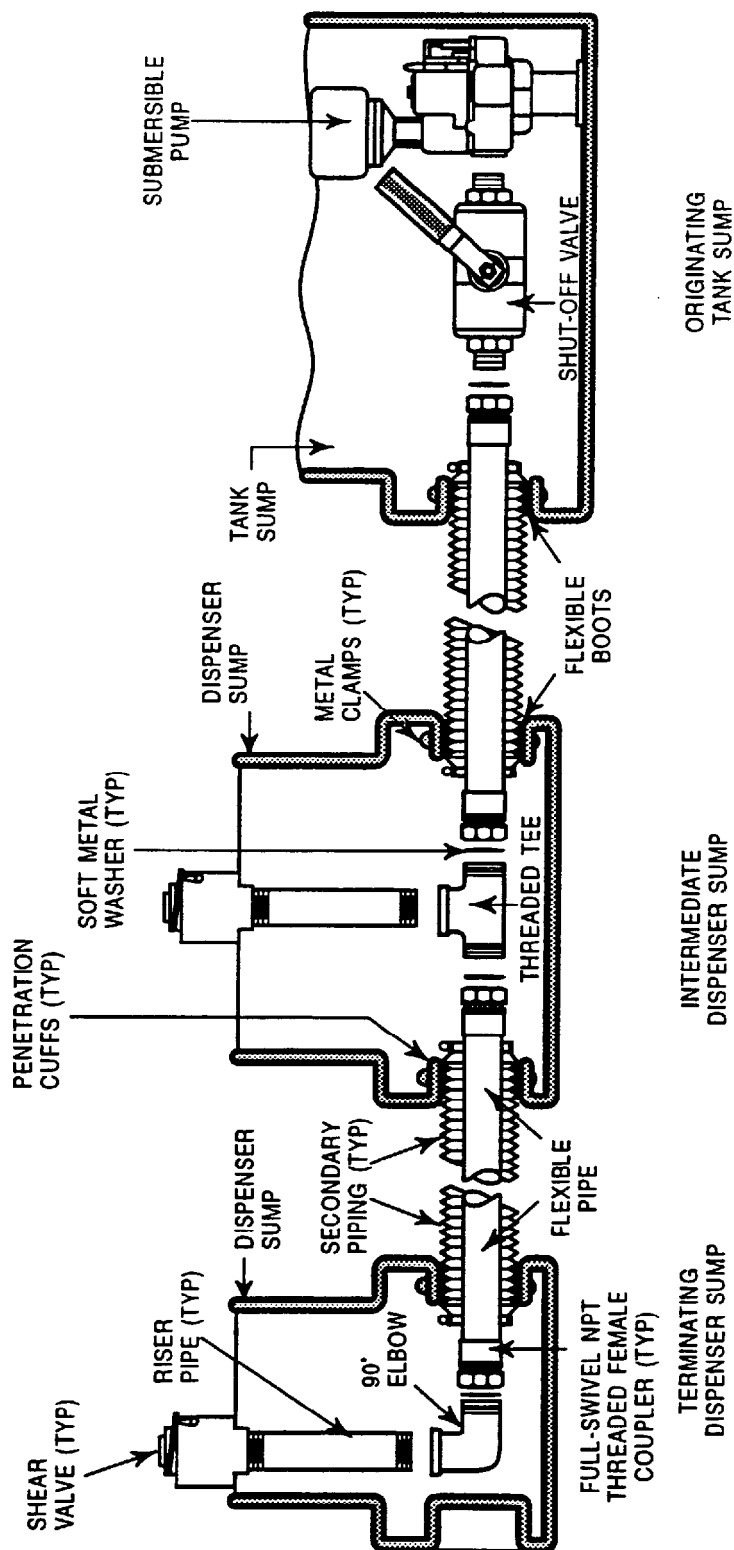


EXHIBIT 5A

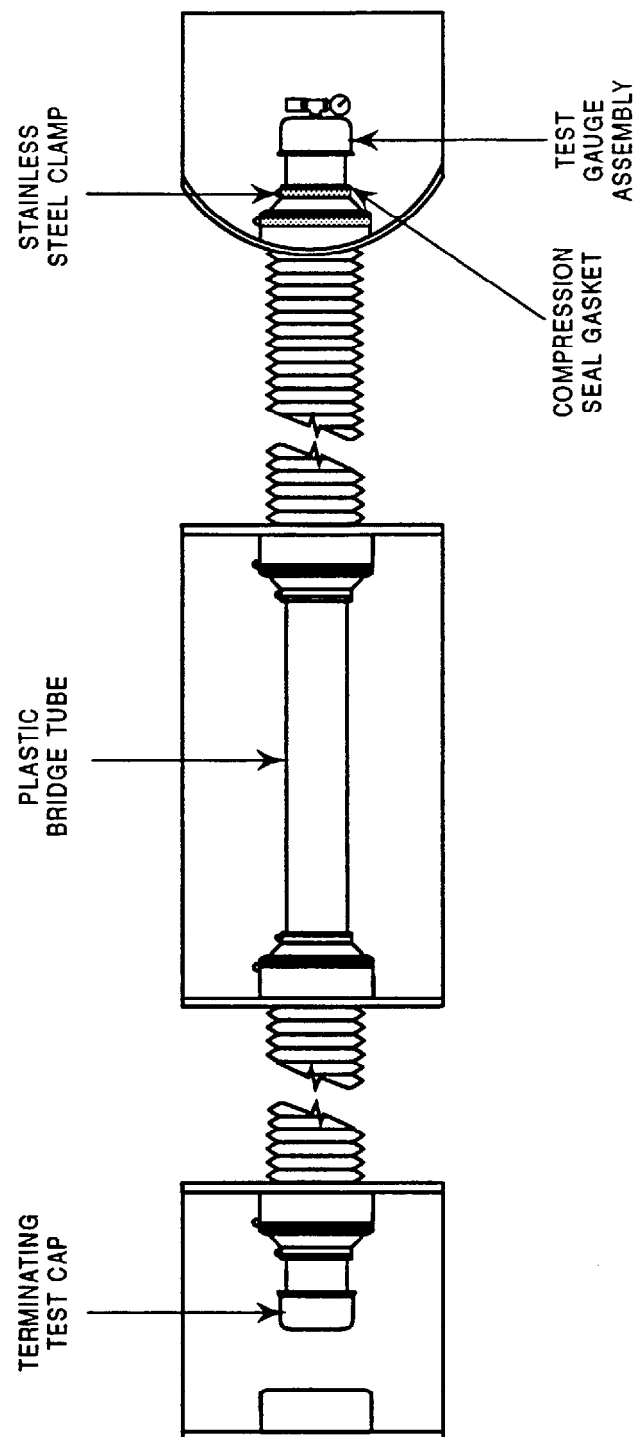


EXHIBIT 5B

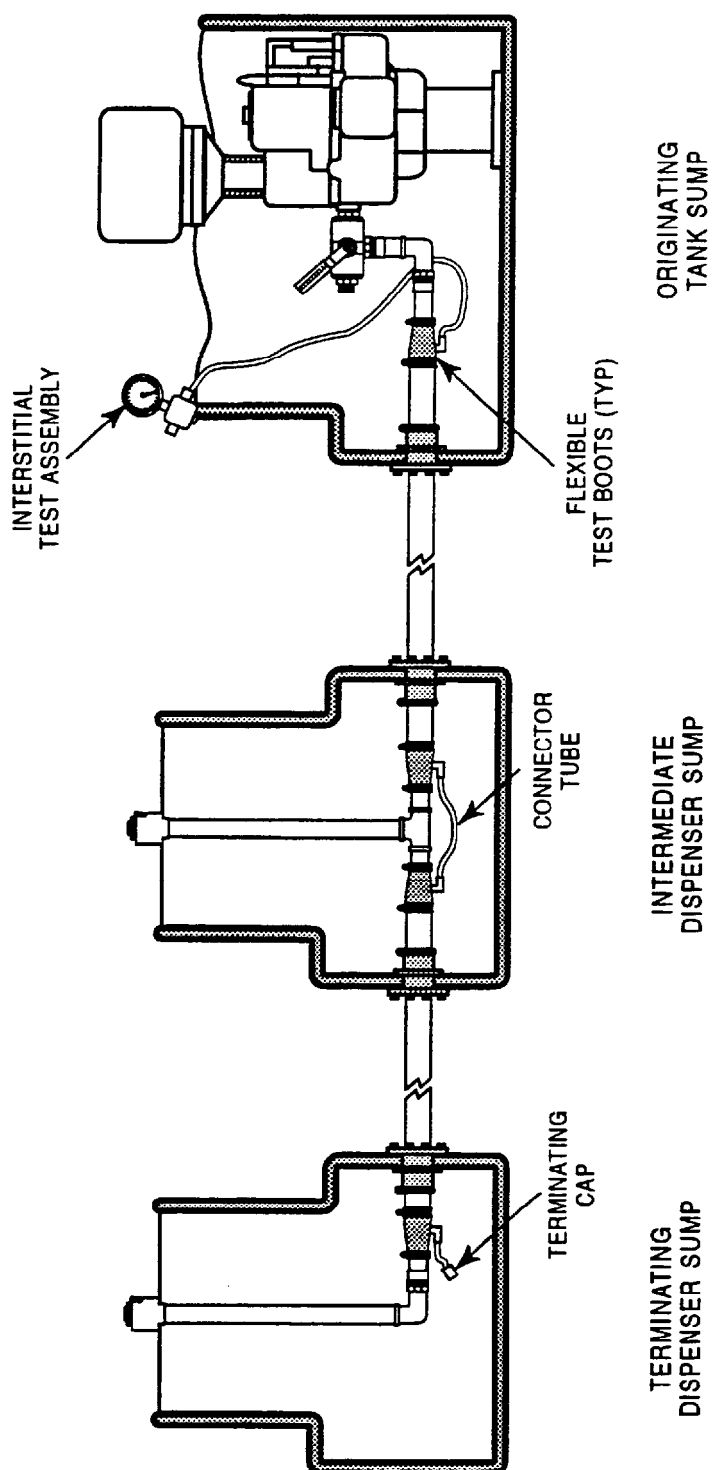


EXHIBIT 6

SEALING METHODS

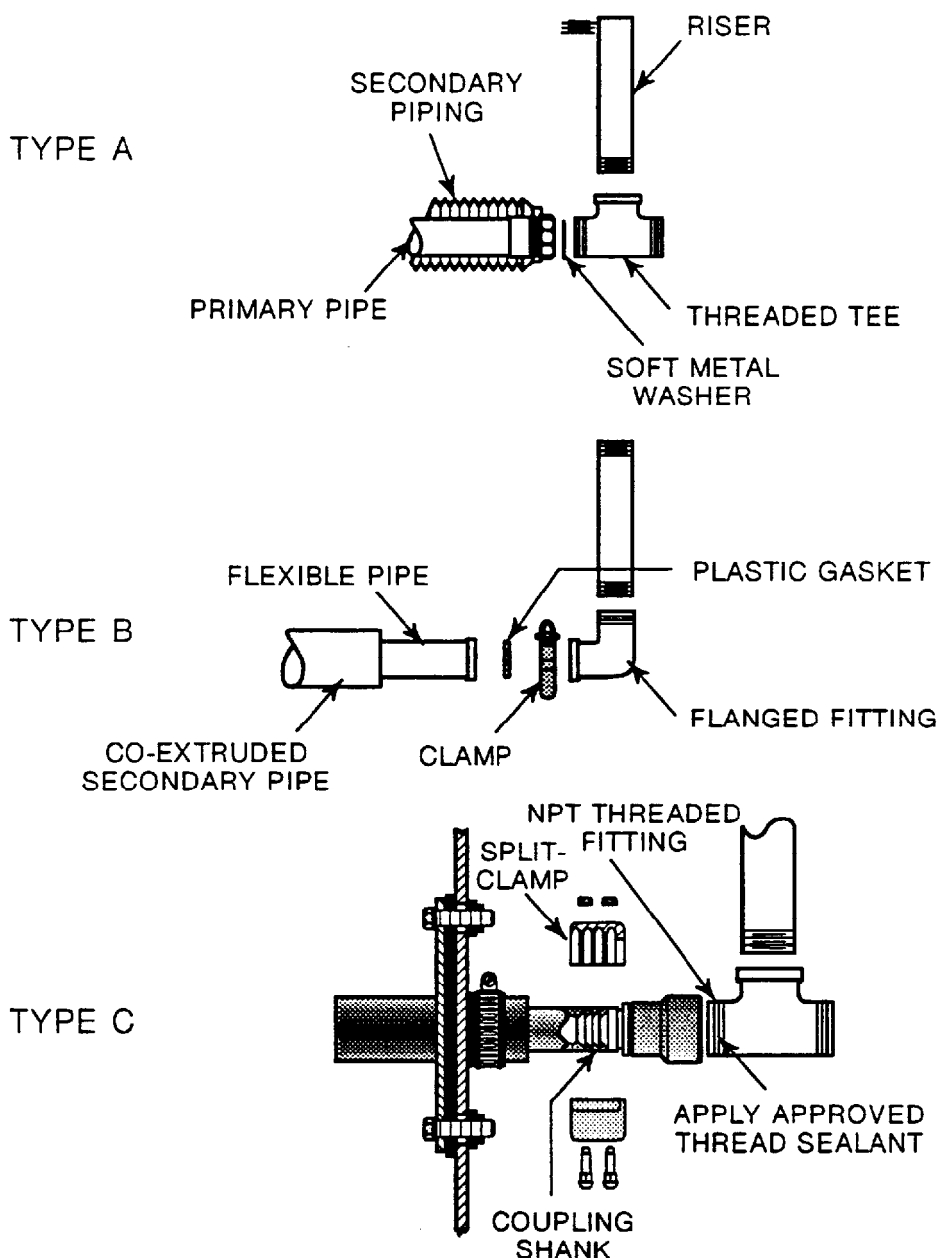
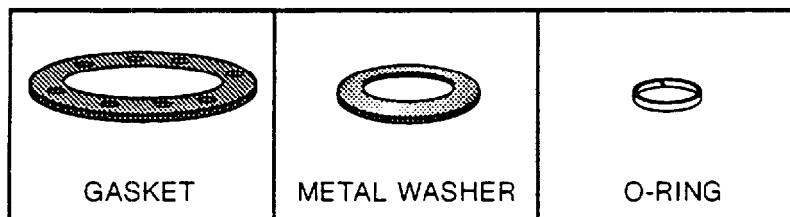
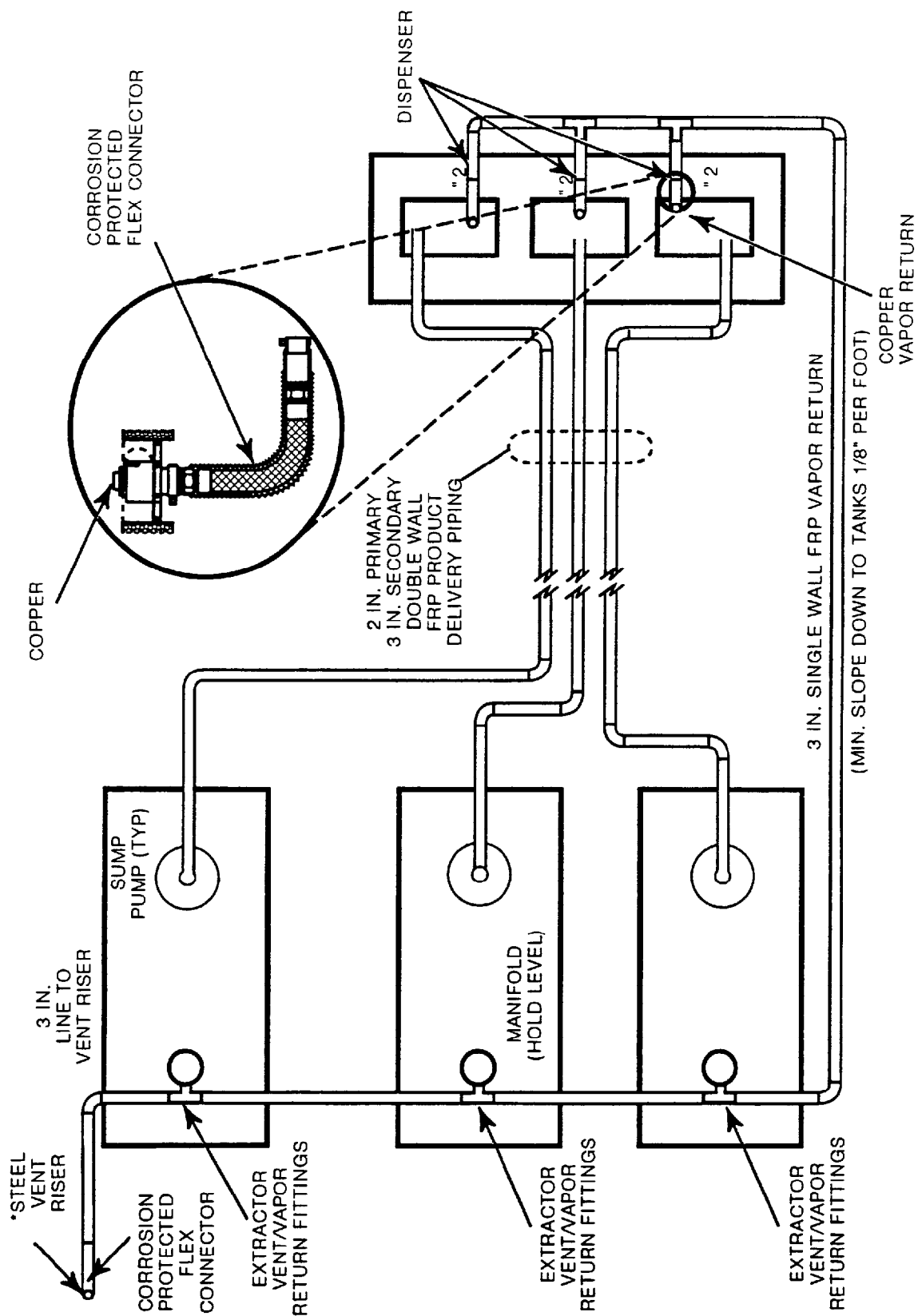


EXHIBIT 7



*CHECK WITH LOCAL JURISDICTION FOR REQUIREMENTS REGARDING NUMBER AND CONFIGURATION OF VENTS

EXHIBIT 8

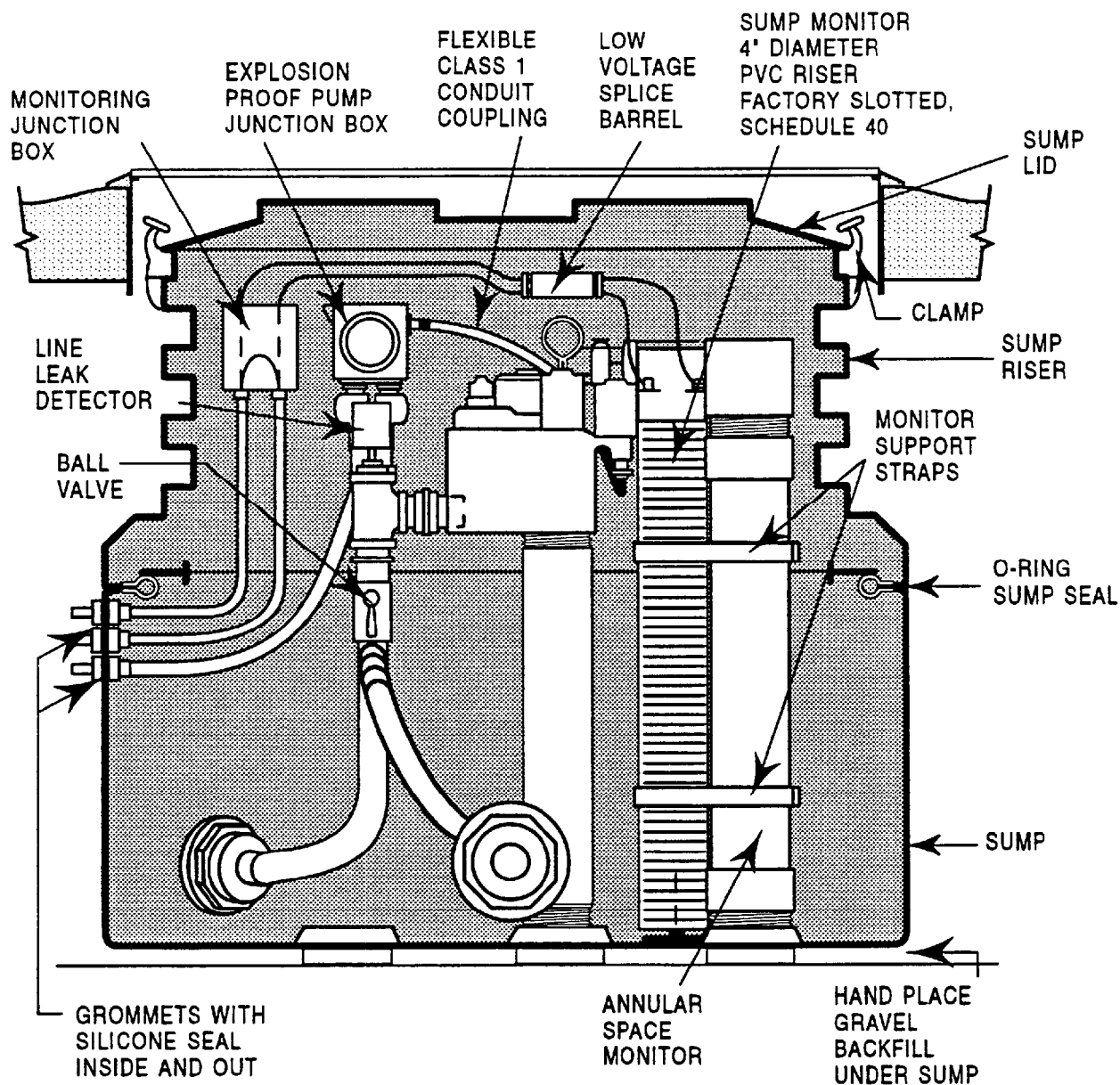


EXHIBIT 9

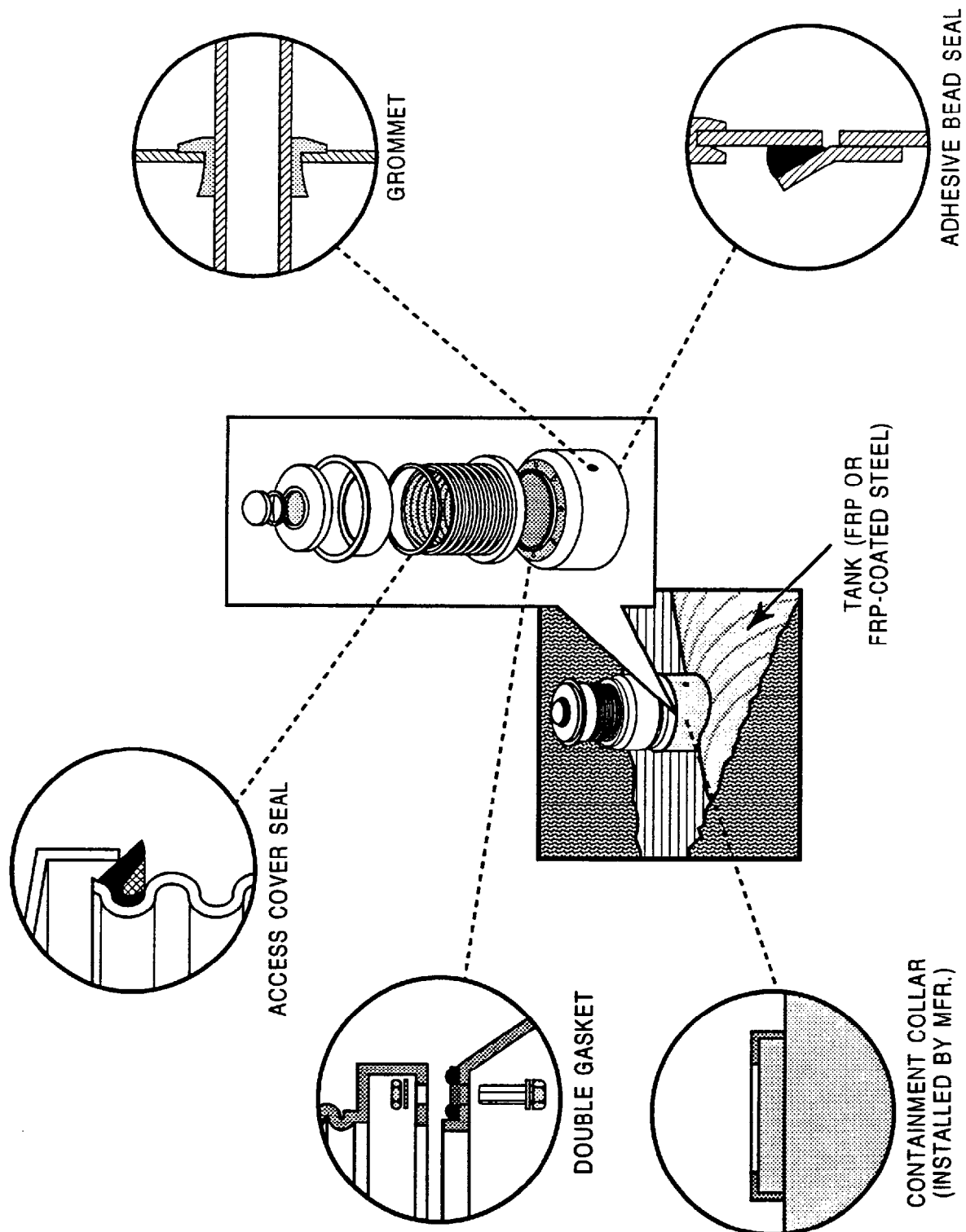


EXHIBIT 10

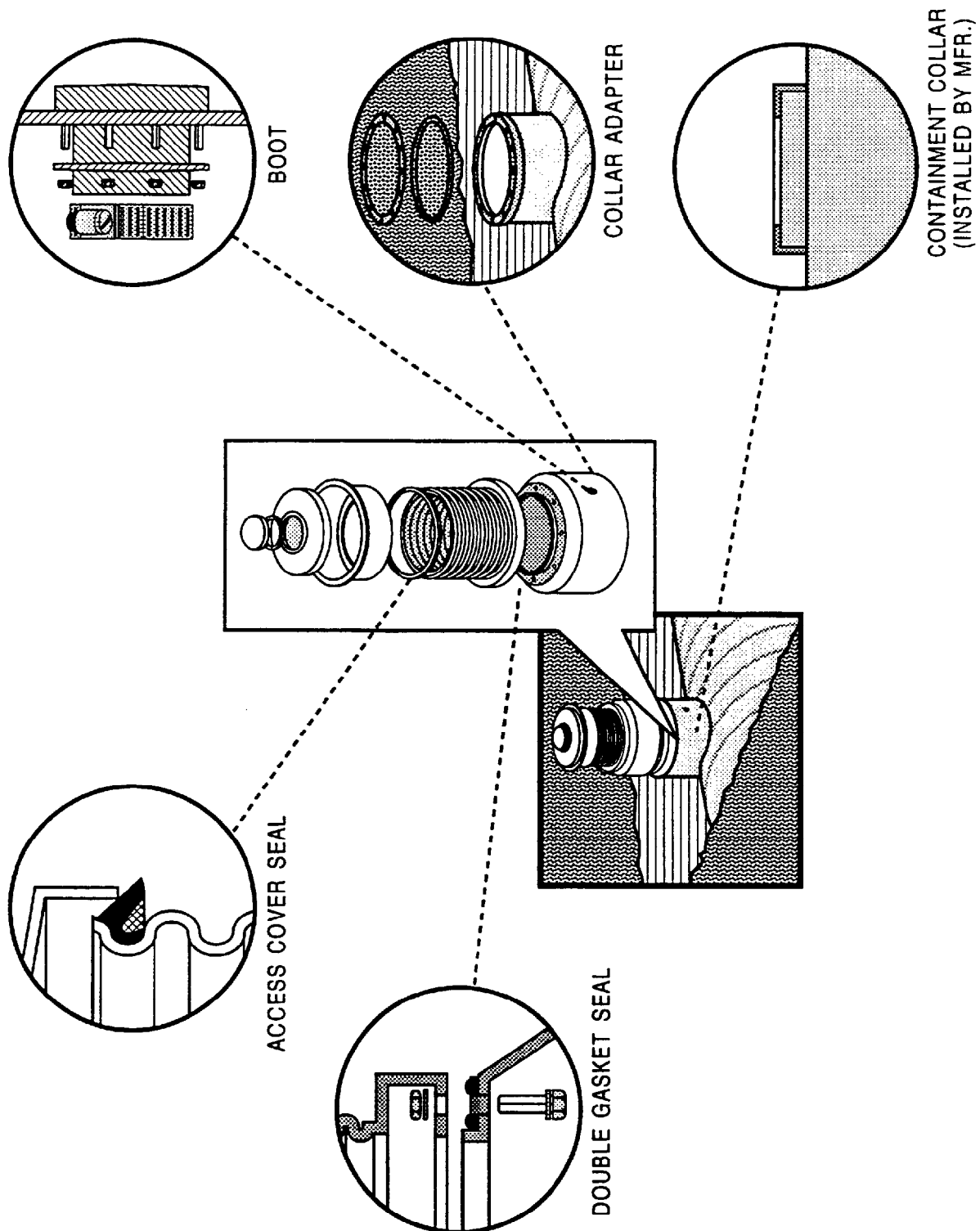


EXHIBIT 11

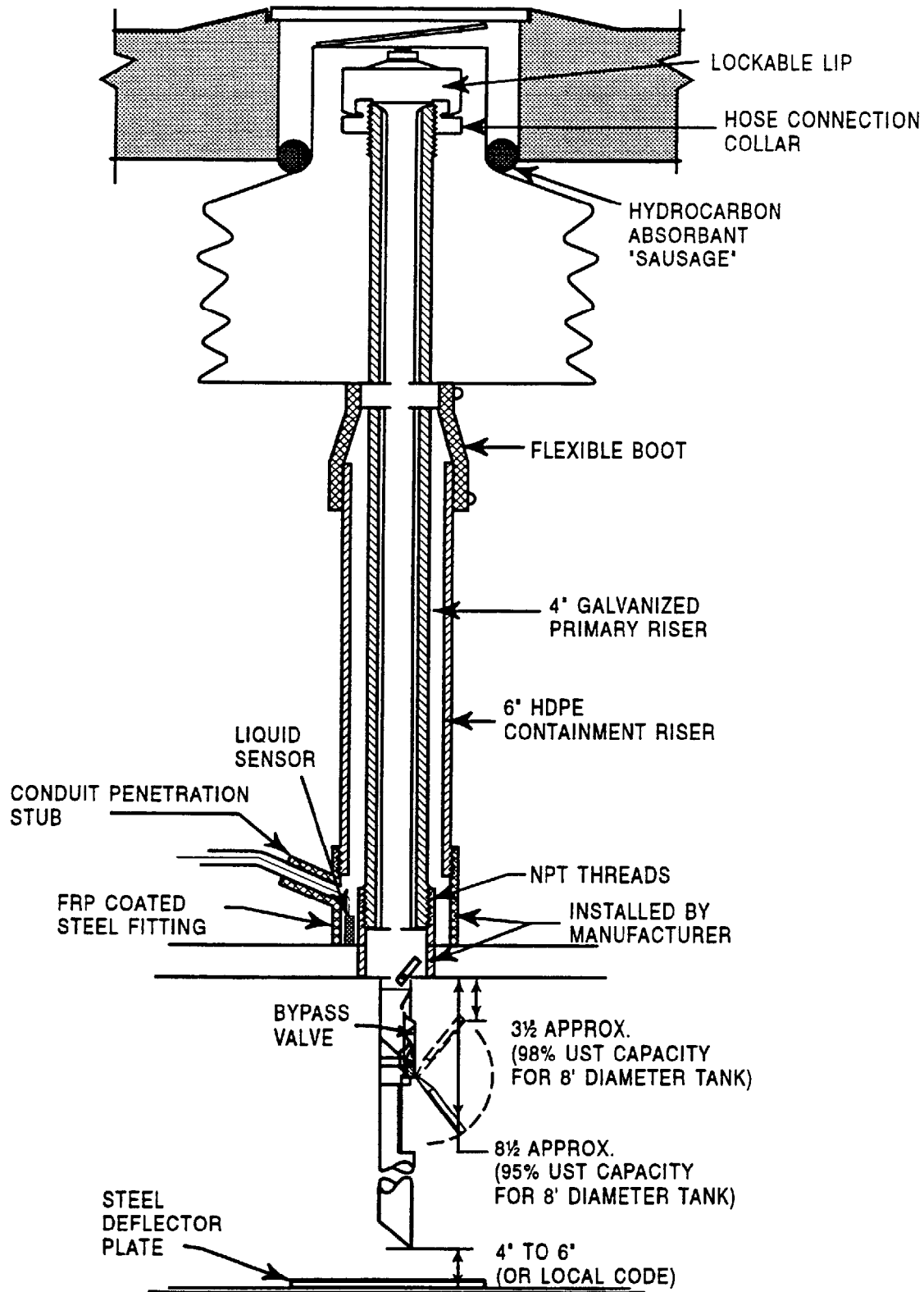
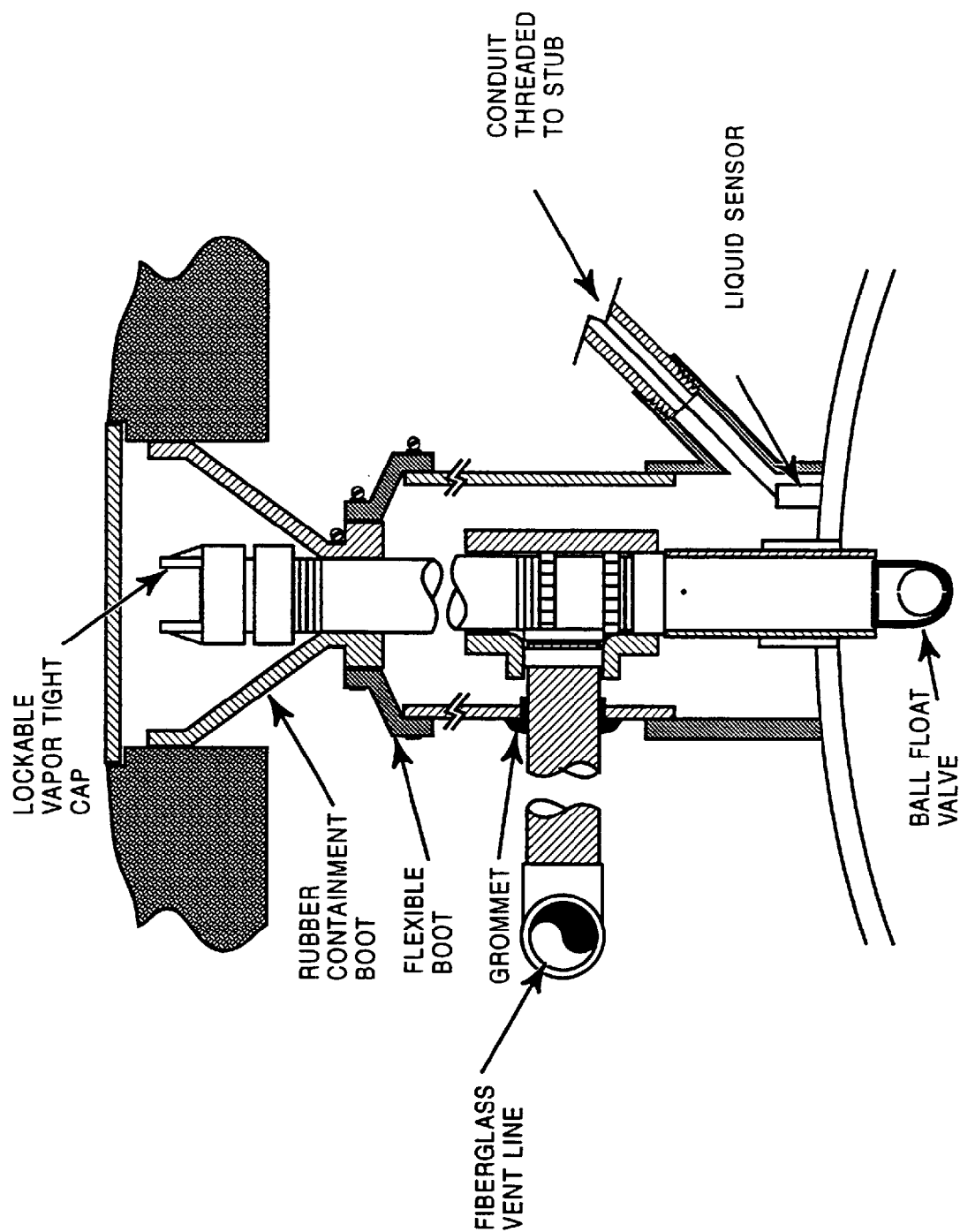


EXHIBIT 12



American Petroleum Institute
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Order No. 804-1663C

Underground Storage Tank Installation Workbook

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UNDERGROUND STORAGE TANK INSTALLATION

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INTRODUCTION

In surveys, the American Petroleum Institute and the U.S. Environmental Protection Agency have determined that a great many of the problems with underground petroleum storage tanks don't just "happen," but maybe the result of improper installation practices. This program provides you with important information regarding proper tank installation practices as recommended by the American Petroleum Institute (API), the Petroleum Equipment Institute (PEI), National Fire Protection Association (NFPA), various equipment manufacturers, and the construction-related requirements of the Occupational Health and Safety Administration (OSHA). The overall objective of the program is to help all persons involved in the installation of underground storage tanks improve their ability to perform their jobs safely and correctly.

The program covers five major subject areas:

1. Excavation.
2. Preinstallation handling and storage procedures.
3. Liners, anchoring, installation, and backfill.
4. Piping components and installation (including metal, FRP, and flexible systems).
5. Secondary containment, spill containment and overfill prevention, and release detection.

Before starting the program, read "HOW TO USE THE PROGRAM MATERIALS" and "HOW TO USE THE SELF-TEACHING FRAMES" on the following pages.

TURN TO THE NEXT PAGE AND READ THE MATERIAL.

HOW TO USE THE PROGRAM MATERIALS

In this program you begin by watching the video portion of the program. This section runs about five minutes. Then you turn to an exercise in the workbook when instructed by the narrator. The workbook introduces you to new learning material and reviews what you learned in the video segment. Once you have finished working and reviewing the material in the workbook, you will be given instructions to view the next part of the videotape.

Going from the video material to the manual and then back to the video material again helps you apply what you are learning. This instructional method also reinforces important information so that you thoroughly understand one concept before moving on to the next.

Here is how instructions in the workbook are arranged:

INSTRUCTIONS TELLING YOU TO TURN THE PAGE, REFER TO ART-WORK, OR WORK PROBLEMS IN THE WORKBOOK WILL APPEAR TO THE LEFT OF THE PAGE IN CAPITAL LETTERS LIKE THIS.

INSTRUCTIONS TELLING YOU TO STOP OR START THE TAPE, OR OTHERWISE MANIPULATE THE AUDIO-VISUAL EQUIPMENT WILL APPEAR IN CAPITAL LETTERS ON THE RIGHT-HAND SIDE OF THE PAGE.

Most workbook exercises will follow this outline:

1. You view part of the videotape program.
2. The taped narration tells you to stop the equipment.
3. In the workbook, you read over several vocabulary words until you are familiar with them.
4. You read a short paragraph that introduces some new learning material.

TO CONTINUE "HOW TO USE THE PROGRAM MATERIALS," TURN TO THE NEXT PAGE.

5. Next, you work the new learning material, which is a series of self-teaching "frames." You read and answer the questions at your own pace.
6. At the end of the workbook period, you work a short review. The review questions are a self-test for your benefit so you can check your learning progress.
7. After the review, you view the next part of the program.

Before you start the program, you should get instructions from the person who administers your training on how to operate the equipment.

NOW, READ "HOW TO USE THE SELF-TEACHING FRAMES" ON THE NEXT PAGE.

HOW TO USE THE SELF-TEACHING FRAMES

The workbook questions and problems included in the new learning material are written in a series of self-teaching "frames." Each frame gives you some information and asks you to make use of it. Or, the frame refers to a drawing and asks questions or poses a problem about it.

Self-teaching frames are divided into two columns. The left-hand column on the page has the learning material. You read this material first. The right-hand column has the correct response or responses for the frame. You read the right-hand column after you write in or select a correct answer to the frame.

Here's an example:

The material to learn or read is always on the left-hand side of the page. Answers are on the right-hand side.

You should cover up the (right- / left-) hand side of the page. right-

It's important to know that self-teaching frames are not a test. They are a way to help you learn faster and more effectively. You learn the correct response to each frame before you move to the next frame and learn additional material.

**GO TO THE NEXT PAGE AND WORK
THE SAMPLE FRAMES. BE SURE TO
USE THE CARDBOARD MASK.**

v

SAMPLE FRAMES

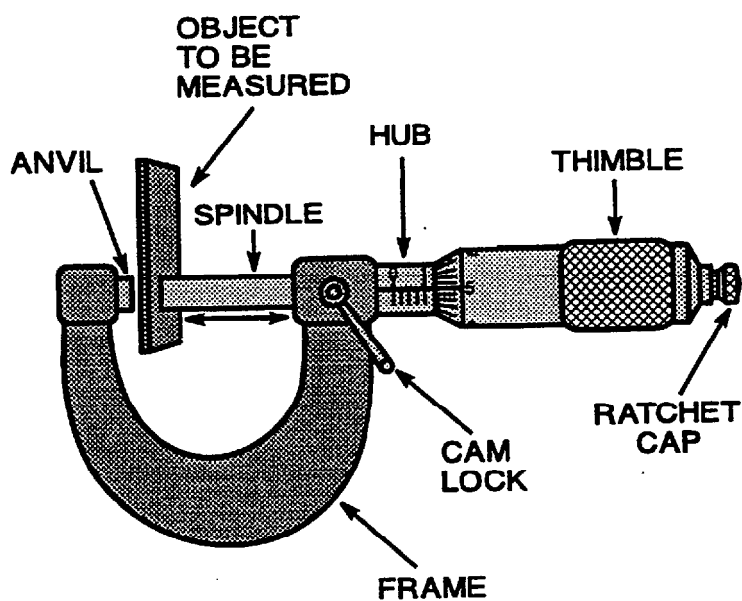
Read this frame and use the information it gives to fill in the blank. Cover the right-hand column.

A micrometer is an instrument designed to measure in thousandths of an inch.

A micrometer is a good tool for measuring very _____ differences in size. small

Move the mask down to uncover the work at the right of the frame. If you have filled the blank with "small" or a word that means the same, go to the next frame.

This drawing of a micrometer provides information that will help you fill in the next blanks:



Seven major parts are shown in the drawing, but only the _____ and the _____ contact the object to be measured.

anvil; spindle

The next sample frame calls for a choice. Circle or underline the appropriate word.

Of the two parts that contact the object, only the
(anvil / spindle) moves.

spindle

The self-teaching frames in the workbook will be similar to the frames you just worked. Remember to cover the response column with the cardboard mask.

Read the frame.

Use the information, a set of drawings, or information you have already learned to fill in the blanks or make a choice.

Move the mask down and check the response column.

Go on to the next frame.

Be sure that you *write* in all your answers. This helps you learn more than if you just think about the correct answer for each frame.

BEFORE STARTING THE PROGRAM,
REMOVE THE EXHIBIT BOOKLET
FROM THE CENTER OF THIS
WORKBOOK AND LAY IT ASIDE.
REFER TO THE EXHIBITS AS THEY
ARE MENTIONED IN THE
SELF-TEACHING FRAMES.

CLOSE YOUR WORKBOOK AND
START THE PROGRAM.

**WORKBOOK PERIOD
NUMBER 1
EXCAVATION**

VOCABULARY

Read over these definitions until you are familiar with them.

OSHA SIMPLIFIED SOILS
CLASSIFICATION METHOD – a method for determining the sloping requirements for
excavations less than 20 feet deep.

NEW LEARNING MATERIAL

This part of the program covers the basics of tank excavation, including clearances, depth/cover requirements, sloping and shoring, and trenching.

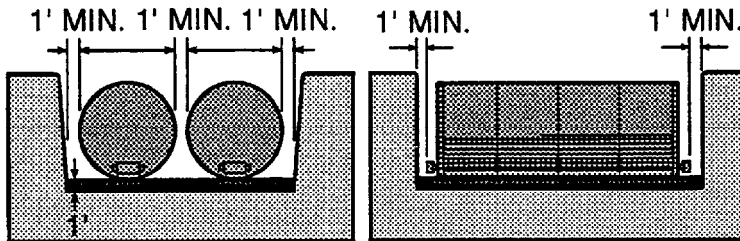
TURN TO THE NEXT PAGE.

SELF-TEACHING FRAMES

Use the cardboard mask to cover the response column.

Clearances

1. This drawing shows the minimum clearances and separations recommended for steel tanks.



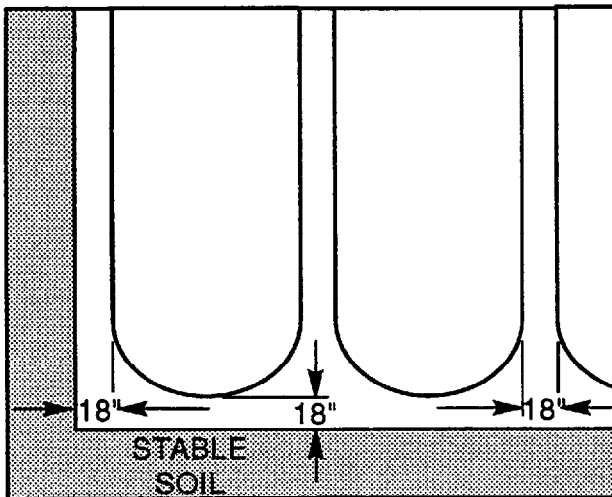
The minimum clearance between the sides and ends of the tank and the walls of the hole is _____ inches.

12, or twelve

2. The minimum separation between steel tanks is _____ inches.

12, or twelve

3. This drawing shows the clearances and separations recommended for fiberglass reinforced plastic (FRP) tanks in stable soil.



The minimum recommended clearance around the fiberglass tanks is _____ inches.

18, or eighteen

4. And, 18 inches is also the minimum _____.

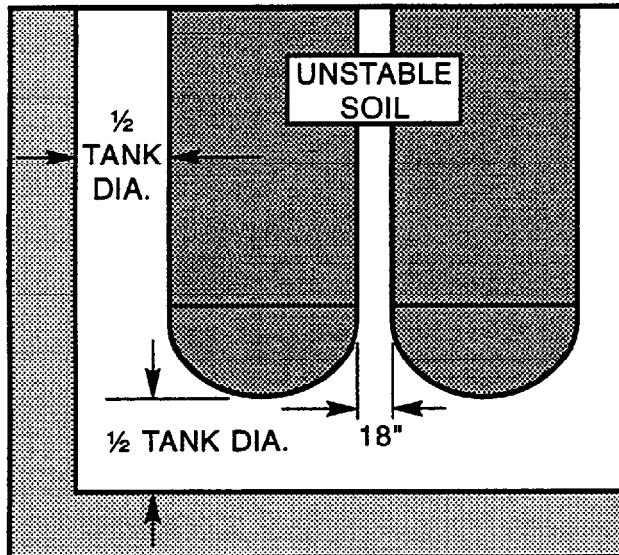
separation

5. The Petroleum Equipment Institute (PEI), in PEI/RP100-90, recommends 24 inches minimum separation and clearance.

This larger separation and clearance allows easier placement and compaction of _____.

backfill

6. This drawing shows the minimum clearances and separations for FRP tanks in *unstable* soil.



The minimum clearance between the sides of the tank(s) and the walls of the excavation is one half of the tank _____.

diameter

7. For a tank that is eight feet in diameter, the minimum clearance is _____ feet.
8. The minimum clearance between the tank end cap and the excavation wall is _____ feet.
9. The minimum separation between tanks is _____ inches.

4, or four

4, or four

18, or eighteen

Excavation Depth/Cover Requirements

10. A dry area is defined as an area where the water table is not expected to reach the bottom of the tank.

So, an area where the water table may be expected to rise above the bottom of the hole is a(n) _____ area.

wet

11. The excavation and minimum cover recommendations are basically the same for both steel and FRP tanks.

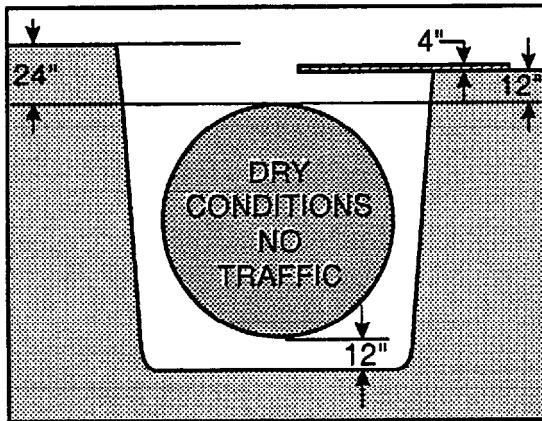
But, different tank manufacturers and local jurisdictions may have their own _____.

requirements, or
recommendations

12. You should be sure to check if you have any doubts regarding the depth of the excavation or the minimum _____.

cover

13. This drawing shows the minimum depth and cover requirements for a tank in a dry area not subject to traffic.



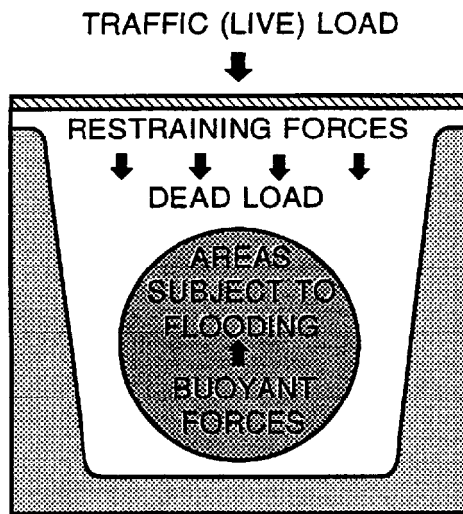
If the tank is covered by backfill only, the cover depth may be as little as _____ inches.

24, or twenty-four

14. The backfill cover is reduced to 12 inches if the finished grade is to be covered by 4 inches of reinforced _____.

concrete

15. This drawing shows the forces acting on a tank in a wet area (subject to flooding).



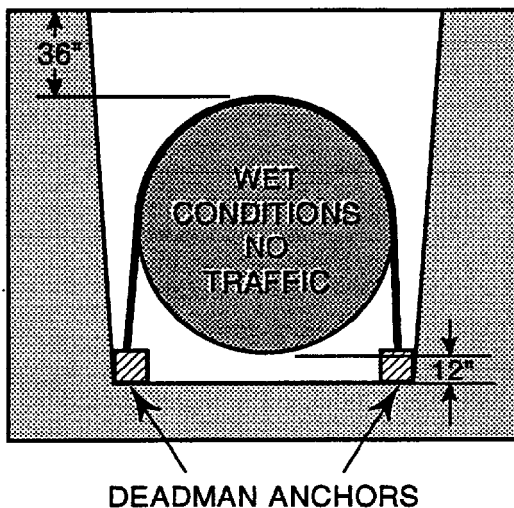
The buoyant forces on the tank are offset partially by the restraining forces, that is, by the weight of the tank, backfill, and _____.

pavement

16. If the restraining forces are smaller than the buoyant force, the tank will _____ out of the ground.
17. Or, if the tank can't break through the concrete (or maybe even if it does), it very likely will be damaged badly so that it _____ product.
18. To prevent flotation of tanks in wet areas, most tank manufacturers require some sort of holddown device.

float, rise, or pop

leaks or releases



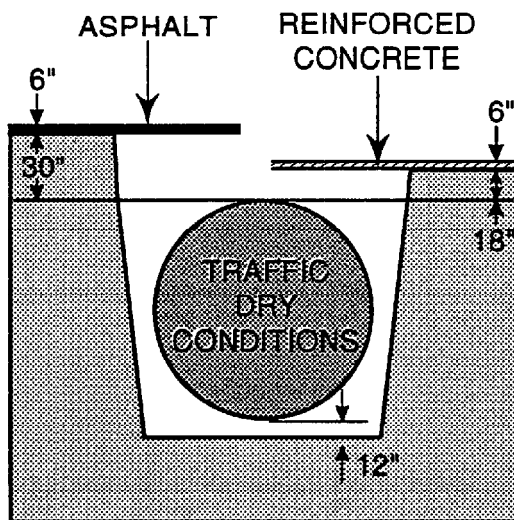
The holddown device may be a concrete anchoring slab or, as in the drawing, two _____ anchors.

deadman

19. The minimum depth of the cover from finished grade to the top of the tank is _____ inches.

36, or thirty-six

20. This drawing shows the minimum depths for a tank installation in a dry area that is subject to traffic.



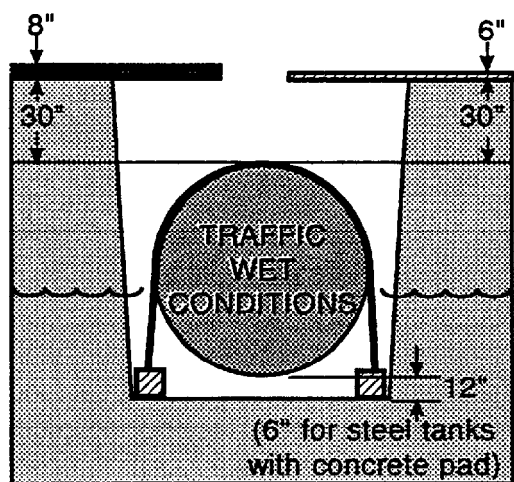
The minimum cover is 30 inches of backfill and 6 inches of _____.

asphalt

21. Or, 18 inches of backfill and 6 inches of _____.

reinforced concrete

22. This drawing shows the minimum depths for a tank in a wet area that is subject to traffic.



Holddown devices (are / are not) required.

are

23. The minimum cover is 30 inches of backfill and _____ inches of asphalt.

8, or eight

24. Or 30 inches of backfill topped by 6 inches of _____.

reinforced concrete

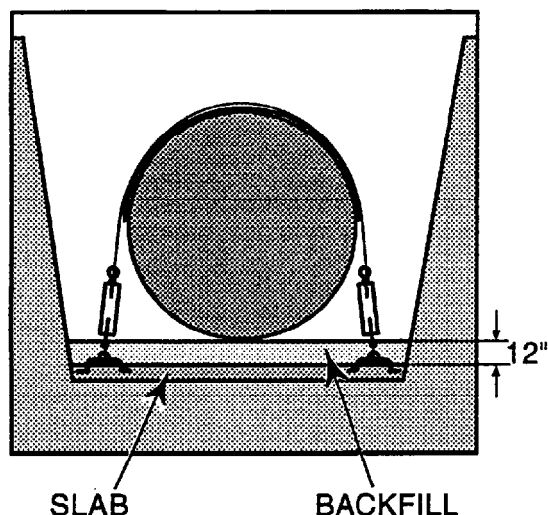
25. In all these examples, there is a layer of backfill under the tank that is _____ inches thick.

12, or twelve

26. For steel tanks with a concrete pad this layer can be _____ inches thick.

6, or six

27. This drawing shows the support requirements for a tank with an anchoring slab.



The tank sits (directly on the slab / on a 12-inch layer of backfill).

on a 12-inch layer of backfill

28. Setting the tank directly on the slab is not allowed, because it might result in uneven loading of the tank.

Uneven loading could cause structural failure and a _____ of product.

leak or release

Sloping and Shoring

Please refer to Exhibit 1, which provides information on the sloping requirements for excavations less than 20 feet deep according to the OSHA Simplified Soil Classification Method.

29. According to Exhibit 1, there are _____ options for designing an excavation protective system.

4, or four

30. Of these options, two require the approval of a professional _____.

engineer

31. As determined by the different options, the angles of the slope for a given excavation (will be the same / may be different).

may be different

32. If different options result in different slope angles, you may use the (steepest / flattest) angle. steepest
33. Options 1 and 2 do not require soil testing or a professional engineer.
The quickest option for determining an acceptable slope is number (1 / 2). 1
34. But this option may result in the excavation of (more / less) soil. more
35. The more soil removed, the (more / less) expensive the excavation. more
36. Compared to the cost of excavating additional soil, it is usually less expensive to be more exact in determining the _____ of the excavation. slope
37. The most important objective of excavation design is improved (cost / schedule / safety / regulatory compliance). safety
38. Unstable soils are defined as those soils whose unconfined compressive strength is less than 750 psf (0.375 tsf).
According to the data in Exhibit 1, Type C soils (are stable / are unstable / may be stable or unstable). may be stable or unstable
39. The lowest slope is required for well-rounded loose _____. sand
40. The slope for this type of soil may be no greater than _____: 1. 2
41. The slope for Type C soils, as given in both the table and the drawing, cannot be greater than _____: 1. 1½
42. Type B soils are (stable / unstable). stable
43. The slope for Type B soils may not be greater than _____: 1. 1
44. Type A soils are _____. stable
45. Shoring or sloping (is / is not) required for Type A soils. is
46. The slope for Type A soils normally may not exceed _____: 1. ¾

47. The type which does not require shoring or sloping is stable _____. rock
48. According to the asterisked (*) note on Exhibit 1, OSHA regulations sometimes allow a maximum slope of _____:1. $\frac{1}{2}$
49. This slope is allowed only under certain conditions.
First, the excavation must be in Type _____ soil. A
50. Second, the excavation cannot be open for more than _____ hours. 24, or twenty-four
51. Third, the excavation can be no deeper than _____ feet. 12, or twelve

Now let's take a look at how to figure the size of an excavation. (Please refer to Exhibit 2.) We want to bury two 10,000 gallon tanks, each 8 feet in diameter by 27 feet long, in Type A stable soil, with dry hole conditions, subject to traffic, and asphalt pavement.

52. The minimum bury depth to the top of the tank is _____ feet. 3, or three
53. The tank diameter is _____ feet. 8, or eight
54. The minimum backfill under the tank is _____ ft. 1, or one
55. The total depth of the excavation is the sum of these, _____ ft. 12, or twelve
56. The $\frac{1}{2}$:1 maximum allowable slope (can / cannot) be used if the excavation is not open for more than 24 hours. can
57. For an FRP tank, the length at the bottom of the hole is the length of the tank, 27 ft., plus the clearance at each end (2 ft. minimum) for an additional 4 feet.
So the total length at the bottom of the hole is _____ ft. 31, or thirty-one
58. The length at the top of the excavation equals the length at the bottom of the hole, plus the setback from the vertical necessary to achieve the $\frac{1}{2}$:1 _____ slope
59. For an excavation 12 ft. deep, the setback is 6 ft. on each end, or _____ ft. total. 12, or twelve
60. So the total length at the top of the hole is 31 ft. + 12 ft. = _____ ft. 43, or forty-three

61. The width at the bottom of the hole is equal to:
- a) the diameters of the tanks,
8 ft. + 8 ft. = _____ ft.; 16, or sixteen
 - b) the clearance at the sides and separation between
the tanks, 2 ft. + 2 ft. + 2 ft. = _____ ft.; 6, or six
 - c) for a total of _____ ft. 22, or twenty-two
62. The width at the top of the excavation is equal to the
width at the bottom plus the setbacks on each side
to achieve the 1/2:1 slope which, as before, totals
_____ ft. 12, or twelve
63. So the width at the top of the hole is _____ ft. 34, or thirty-four
64. Suppose the owner specified a 12-inch concrete
anchoring slab.
- You would have to excavate another foot, making the
hole _____ ft. deep. 13, or thirteen
65. According to Exhibit 1, because the hole is deeper
than 12 ft., the sides of the hole have to be sloped at
the ratio of _____:1. 3/4
66. That makes the setback on each side to be
3/4 x 13 ft. = _____ ft. 9 3/4
67. That is, a total of _____ ft. in both length and
width. 19 1/2
68. The dimensions at the bottom of the hole, 31 ft. long by
22 ft. wide, (change / do not change). do not change
69. Due to the increased setback requirement, the
dimensions at the top of the excavation become:
- a) length, 31 ft. + 19.5 ft. = _____ ft. 50.5
 - b) width, 22 ft. + 19.5 ft. = _____ ft. 41.5
70. The volume of the original hole was 444 yds.; the
volume of this hole is 577 yds., for a difference of
133 yds.
- The requirement for an additional foot of depth for
the anchoring slab significantly increased the
_____ of the excavation. size, dimensions,
or volume